

METHODS OF COMPILATION USED IN PREPARING CENSUS AND REGISTRATION REPORTS.

BY DR. GARDNER T. SWARTS,

SECRETARY STATE BOARD OF HEALTH OF RHODE ISLAND.

Owing to the increased interest in vital statistics evinced by one of our western states, and the stimulus given to other states by the zealous agitation of the subject, by its earnest registrar, I have been requested by the President of the Association to present such facts as are available as to the various methods at present in use, for the computation, or compilation, of the data to be found in the return, or certificate, of death.

From the earliest times, a record of successive incidents of the same kind was kept by means of markings, and varied signs, upon parchment, tile, or stone. The aborigines of this country were in the habit of keeping their record hanging at their belt, in the form of scalp-locks, taken from their victims, while the earlier settler recorded his mortality statistics of aborigines destroyed, by notches cut into the stock of his gun.

At the present time, with the ready means afforded by the use of plumbago, inks and paper, the simplest form of notation has been what is called, "the dot and dash system," a successive dot or dash being set against each distinct item that the data on the return presented. These in turn are counted, and the total set against the item. A variation is made at times between the dot and the dash, or any other distinctive mark, or check, which permits of the more ready discovery of the particular bundle of returns which are successively examined.

One of the disadvantages of this system consists of the impossibility of determining which individual return has been noted incorrectly. If a failure is made to place a dot or dash, the discovery is not made until the total is made up; it then becomes necessary to do the work all over again, since the individual return which is omitted cannot be distinguished.

As an assistance, both in rapidity and convenience, in recording the tally, a self-counting, or tally sheet, was devised by Mr. Chas. F. Pidgin, who has been connected with the statistical work of the Massachusetts Bureau of Statistics of Labor for the past twenty-nine years, filling the position of Chief Clerk of that Bureau since 1876. This sheet consists of a separate line for each item, the line consisting of a series of dots, the tenth dot being larger and more distinct than the previous nine. The advantage of this form of tally sheet is that the

total may be read off at any time without counting up the number of dots or dashes. Variations of the form of dot, dash, bracket, or circle indicating the tally, may be used on these sheets to indicate different data, but which might be desirable in connection with the data first entered upon the same line, such as a different district, ward, or town.

This is more useful when the number of returns counted are small. It has the disadvantage of any dot and dash system.

In the course of his association with statistical work, and from his experience of the needs of the forms of work, Mr. Pidgin has invented and introduced many devices for facilitating the work of compilation.

The first of these was the use of the slip, or card system, upon which the whole data of the return was marked. These cards, or slips, were sorted into boxes, or racks, according to the data given upon the cards. These cards could then be counted, and if any deficiency was found in the total, the individual pack, or sort, could be quickly run through, and the missing or mistaken item found.

As an adjunct to the original Pidgin System, the trays, or boxes, receiving the cards were supplied with lids which closed automatically, by means of a stiff spring, but upon being opened, press upon a counting dial, thus giving the result of the count at the end of a sorting. This did away with counting the cards by hand.

As a part of the original system, and as a check against the introduction of a wrong card into the sort, or boxes, the record of the return was indicated by holes punched into the cards against the various data required. This punching was done by means of a hand puncher. A bunch of these when sorted would each necessarily have the same corresponding hole, and a wire being passed through this hole in the collected bunch, would meet with no resistance unless a wrong sort had been made, in which case the offending card could be withdrawn and placed in its proper division.

Improvement was next made upon the sorting boxes, by introducing into boxes a simple but effective counter which is operated by hand when the cards are sorted into their respective compartments. This form of machine, called "The Automatic Multiple Counting or Tabulating Machine," was devised and used by Mr. Pidgin in compiling the State Census of Massachusetts in 1895. This machine is operated directly from the original schedule, or return. It consists of a box having saw-tooth slits across the tin front. By lightly pressing a projecting arm, or wire, a spring throws this arm into the slots between the teeth. Each slot has a number indicated over it from one to nine. The lowest row indicates units, the second tens, the third hundreds, and the fourth thousands. When the unit arm has reached slot nine it is thrown back to zero with one sweeping motion, and the lever, or arms, of tens

is touched once, throwing it into the first notch of the tens. Thus, by the aid of this simple device, counts may be made as high as ten thousand.

A device called "The Pin Board Electrical Tabulating System" was next produced by Mr. Pidgin. This consists of a stack of 108 counting machines which automatically adjust themselves at zero as the result of simply pressing a button. These counters are erected before the operation, and are set in motion by an electrical connection which is operated from a pin board. A card having letters or characters representing the items to be recorded, is placed over the pin board, and the pin and punch are driven through the card at the items indicated. This operation causes the counters to register and at the same time produces the punched card, thus accomplishing two results with one motion.

For this pin board may be substituted what Mr. Pidgin terms, "The Electrical Typewriter Tabulator." The keys of the typewriter may be marked with transferable labels indicating the 108 items which are to be counted.

This machine is operated directly from the schedule, or return. This does away with the use of a card and with punching. Twenty-one index keys, or guides, are arranged on two sides of the keyboard which gives a guide to tabulation. By using the index, or guides, in correlation with the keys, a combination of items may be registered by the pressure of one key. In this way it is possible with one stroke to count the items of sex, nationality, color, conjugal relation, and age periods.

Mr. Pidgin claims that if this form of machine is operated even as slowly as one-half the ordinary speed of the typewriter, that 105 tables may be made per minute, or 6,300 registers per hour, or 44,100 tables per day of seven hours.

A "Multiple Adding or Chip System" has been used by Mr. Pidgin for a number of years. This system is for adding small numbers where a great number of totals are desired. Its capacity is from units to millions. Colors are used to indicate units, tens, etc. The digits are printed in large characters, the six being distinguishable from the nine. The operator selects the card numerals from the case as a type-setter would pick his type.

By this process, two hundred columns may be added at a time with only one result slip for the totals. The chips are counted after being drawn from the rack in which they are sorted. This may be done by using any of the counting devices previously described, the typewriter tabulator being the most satisfactory. As the cards are counted, they may be sorted into a sorting box near by the operator, and thus be available at once for placing in the rack from which they are first drawn.

A device similar in operation to the "Pin Board Electrical Tabulating System," but differently constructed, has been devised by Mr. Herman Hollerith, of Washington, D. C., and is known as the "Hollerith Electrical Tabulating System."

This system consists of first preparing a card of exact size and shape upon which is printed the numbers, or the letters, which shall correspond to all the data which can possibly be found upon any given return of death or schedule of census.

Inasmuch as the causes of diseases, as well as occupations, are exceedingly numerous, it is found impracticable to represent each disease by a given number, or sign, but it is feasible to indicate the several classes of causation, and to indicate by a specific number, the subdivisions of those classes.

By a specially prepared machine, these numbers, or signs, are punched out of the card for each item of the data given on a single return; this card, therefore, represents the return, reading in the form of punched holes. It is now possible to sort these cards by hand, using the punched holes as the heading, but where the number is large, the objection to the original Pidgin system in this method is not removed.

The next detail in the Hollerith System was to sort these punched cards by the use of the electrical sorting and counting device. The punched cards are placed one by one, by hand, upon a rubber slab holding as many small mercury cups as there are indications on the unpunched card. Above the slab with its cups, is suspended an equal number of needles, or wire points. The bottom of the mercury cups are each individually connected with a dial-hand operated by small electric magnets. The needles are individually connected on the opposite pole of the magnets. The card being placed on the rubber slab, the needles are all brought down at once by a single motion of a lever. Certain of the needles will drop through the punched holes in the card, come into contact with the mercury in the cups, thus completing a current through the magnet which releases the hand on the dial one point.

Each time a current is made a register of one is recorded on the individual dial which corresponds to the hole in the card, which, in turn, represents age, sex, color, conjugal conditions, etc. When the digit hand on the dial has completed a count, a second hand tallies one hundred on the dial so that a computation of ten thousand may be made on each dial.

After a certain division, or bunch of cards, representing a city or county has been passed through the tabulating machine, the totals on the dials may be read off and noted on the total tables of the report.

One dial is reserved and placed in a common count which records the exact number of cards which pass through. The total, therefore,

of any given item, as for instance in color, the total of black, white and mixed must be equal to the total on the reserved dial. By this means any failure to have punched the card for these items, or failure on the part of a dial to record, is immediately noted and the card discovered by running the bunch through and noting the total for every five or ten cards passed.

Since the number of items called for in the report may number upwards of two hundred and forty, it is evident that this number of dials, each of which is about three inches square, would occupy too much space. An electric connection is therefore made with a sorting box, which consists of a certain number, say 26, all of which have a light metal cover, which is held in place by means of an electric magnet. A sort is made by counting up each cell, or box, with the items, the primary division of occupations, or of divorces.

When the needle passes through the item hole, the contact of the needle with the mercury causes the lid, or cover, of the box to be released. A spring throws the cover wide open. The card having been on the record, is slid off by hand into the cell, or compartment, found open. The cover is then thrown into place, by hand, being caught by the hook on the electric magnet and from which it was released when the magnet moved. The opening of the sorting box, and the working of the one or more dials, operate at the same time.

The cards accumulating in the boxes are taken in their sorted bunches to the dial portion of the machine, and a record is made of the holes found in the sub-divisions of occupations, or diseases.

Although each card is placed and removed by hand, yet an operator quickly acquires great celerity and rapidity in the working of the machine. It will be noted that the operator does not read the cards, but the instrument does. The power for operation of the magnets is provided by about twenty-four carbon zinc cells.

When any sort, or bunch, consists of but few cards, they are more readily worked by hand. The limit of this method of sorting and counting varies with the operator. The reading is made by observation of the holes which correspond with the data as given in the original certificate, or return.

As a variation or simplification of the work of punching, a machine has been devised by Mr. Gore, of the Actuary Department of the Prudential Life Insurance Company, of Newark, N. J.

This consists of the union of cutting, or punching, rods with the key-board of a typewriter. In this instrument the cards are fed and expelled automatically to and from the punching blade. As a matter of economy, and for the purpose of having cards accurately cut that there may be no variation in size, which would lead to obstruction in

the several machines through which it passes, Mr. Gore has devised a machine which will automatically cut these cards from strips of cardboard distributed from a roll. These cards are also stamped automatically with a consecutive number, and printed with the letters, or signs, representing the data to be noted.

Mr. Gore's method of sorting consists in placing bunches of the punched cards in a number of hoppers which are arranged on a circular platform, several of these circular receptacles being imposed one upon the other, each being free to revolve independent of the circle above and below. In each circle there are receiving compartments in which the projecting wire is inserted at a point which will correspond with the location of the hole in the card the notation of which is desired. As these circles are readily revolved by hand, or electric motor, each successive card comes in contact with these pins, and if the hole be present directly over the pin, the card will drop into its proper receptacle; if not, it continues to revolve until it finds a point, or pin, which does correspond. In this way all of one age, or different age periods, may be sorted at the same time. These pins are adjustable in sockets for any of the signs found on the cards. In this way the sorting is done with great rapidity, many thousands being separated within an hour.

Succeeding this operation, an instrument has been devised which shall receive these cards from a hopper, and automatically *count* and register the number of cards of any individual sort placed in a hopper. As this does away with the mistakes which are liable to accrue by lack of memory of the hand-sorter, the results are more accurate. A mistake made by the hand-sorter, of passing two cards at one time, is obviated in this counting instrument, since two cards cannot enter at the same time. Any failure to enter checks the operation of the machine.

There is on the market a hand adding machine which will record single tallies, or items, or one subject, to the number of 999, the next pressure upon the projecting lever of the machine throwing the reading dials, or rather registering wheels, over again to 000, making 1,000. These counters are used by umpires of base ball and other games, by inspectors of steam-boats, and in any large assembly to tally the number of persons present.

It is a circular box of metal, about two inches in diameter, with glass center on the front, protecting the registering wheels. Each wheel may be thrown back to zero by means of thumb keys on the back. The wheels are set in motion by pressing a lever which projects on one side. This is useful only in adding by single additions of one or two.

For the purpose of adding numbers including units, tens, thousands

and upwards, a device known as the comptometer is to be found on the market. It consists of a box fourteen inches long and eight inches wide and four inches deep, containing a series of wheels, each having ten notches with a cam on each wheel at the tenth notch which will cause the neighboring wheel to advance one notch, or number. The turn of the wheel is produced by pressing upon a key button upon which is imprinted a number. There are nine digits in each vertical column of units, tens, etc. These buttons press perpendicular rods which force horizontal arms, or levers, to press against the notches on the wheel, the amount of push being governed by the length of arm or the leverage of each number. The numbers being farthest removed from the register or dial has the longest leverage. All the numbers on the dial may be brought to zero by turning a small wheel on the side of the machine.

A device for the same purpose is found in the Electrical Adding and Multiplying Machine of the Pidgin System. It differs from the previous machine by the numbers being notated by means of sliding keys instead of stiff upright keys. The keys, or arms, with pointer, are pushed up on the scale to the number to be added. All of the numbers up to a billion, being set, it is possible to read the numbers off for correction before bringing them back into place and registering on the dials.

This form of machine has the advantage of accuracy, and noiseless and easy of operation, very little effort being required to push the sliding arms into position. The only disadvantage is the necessary width of the machine. An attachment also provides for locking the machine to avoid intentional or accidental movement of the arms by some person other than the operator.

As with the Comptometer, multiplication and division and other mathematical computations may be mechanically executed with the aid of this machine.

As to the advantages of one system over the other, it may be stated that any mechanical device which will relieve the mind, the hand and the eye from continuous routine effort, will serve the avoidance of mistakes. Such devices necessarily increase rapidity of obtaining results, and it is the aim of all registrars of vital statistics to issue their reports at the earliest possible date which is consistent with completeness and accuracy of the information compiled.

The card catalogue system has the advantage of a permanent record, for reference. It has the advantage of sorting by hand, which as has been stated, is preferable in dealing with small totals.

The perforated card system has the advantage of availability of mechanical devices which insure accuracy, but more especially rapidity.

Thousands of cards may be handled in this way when hundreds are counted by hand. One great advantage that this system has, is the possibility of accumulating and sorting to obtain one item, or several, covering a period of five or ten years.

The introduction of the perforated card involves one more process in the operation. The card must be punched by hand, and must be fed to the automatic counting machine.

Reading direct from the schedule, or return, and recording the count automatically by machine, brings the information direct from the return into the total and is thus a saving of time as well as an increase in accuracy. If, however, a mistake is made in recording one too many, or too few of a particular item, it is not possible to correct that except by a re-reading and re-count of that item for all the returns that are in the schedule.

In the use of the dials, with clock hands as indicators, it is very essential that the operator stand directly in front of each dial, for from a

(County)	(City or Town)	(Month)	(No.)
(Color and Race)	(Conj. Cond.)	AGE	
		(Years)	(Months)
(Res. or Non. Res.)			(Days)
Disease or Cause of Death	(Class)	(Order)	(Detail)
Occupation	(Class)	(Section)	(Detail)
Place of Birth and Parent Nativity	P B	PN F	PN M

Massachusetts Registration: DEATHS—1887.

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DEMONSTRATION OF CARD USED IN HOLLERITH TABULATING SYSTEM.

Ja	Fb	0	30	60	0	0	5	00	2	Br	Kt	1	7	M	Dv	A	B	C	D		
Mr	Ap	5	35	65	1	1	6	Days, 10	3	Pv	Nw	2	8	Sex, F	Wd	E	F	G	H		
My	Ju	10	40	70	2	2	7	Days, 20	4	Pt	Ws	3	9	W	Sg	I	K	L	M		
Jy	Month. Au	15	45	75	Years, 3	3	Month, 8	Days, 0	5	Wn	Pv	4	10	B	Mr	N	O	P	Q		
Sp	Oct	20	50	80	4	4	9	Days, 1	6	8	Nw	5	11	Color, Mx	Un	R	Un	1	2		
Nv	Dec	25	55	85	90	Un	10	Days, 11	7	9	City, Cn	6	12	Ot		3	4	5	6		
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point diagonal from the dial, the angle at which it is viewed will give a mistaken notation. With the numerical indicator the numbers are at once evident. No counting of intermediate divisions on a dial is necessary, the total being read off at once and noted on the total sheet.

On May 18th last, a commission on the tabulation test for the next United States Census was appointed. This Commission submitted to the contestants schedules representing approximately 20,000 persons which were selected from the population of the returns of the eleventh census. Individual data was to be obtained from these schedules, and to be represented in twelve tables, comprehending a distribution of the population by sex, general nativity, and color, age, conjugal condition, place of birth, parentage, illiteracy, school attendance, citizenship, occupations, and month's employed.

According to the Washington Star of July 28th, "Four systems of tabulation were entered into competition: First, the Hollerith Electric Tabulating System. Second, the Automatic Multiple Counting Machine. Third, the Pin Board Electrical Tabulating System, and the Electrical Typewriter Tabulator," the latter three being entered by Mr. Pidgin, and all of which have been described in this paper.

The Star states that "the Hollerith System completed its work in 185 hours and 53 minutes when considered as the labor of one clerk. Of this total time, 135 hours and 30 minutes were consumed in transcribing

ing the cards by punching, including 'gang-punching'; 68 hours and 38 minutes in running the punched cards through the electric counting machine, and 11 hours and 45 minutes in transferring the results to the forms of tables as submitted by the Commission. Six hours and 30 minutes of the time was used for the hand sorting of certain of the smaller occupation groups.

The Automatic Tabulating System consumed 452 hours, of which 228 hours were occupied in transcribing (by marking) of the cards. The counting and tabulating occupied 224 hours.

The Pin Board System was not continued through the test but was stopped by agreement, it having been demonstrated that the rapidity of this system was practically the same as that of the typewriter tabulator and the relative efficiency of the two systems could be determined by confining the test to the last named system.

The test of the last three systems was begun on June 14th. Work was continued on the typewriter tabulator until July 27th, when it was discontinued by direction of the Commission. Up to this time 163 hours had been consumed by the test and nine tables were wholly compiled.

The tables relating to foreign percentage and occupation respectively and a part of table seven relating to age detail, had yet to be compiled."

The conclusions as reached by the Commission was as follows: "As the result of the test of the several systems submitted the Commission are jointly and severally of the opinion that the superiority of the Hollerith electric tabulating system for the compilation of individual data which is necessary to be made from the returns of the twelfth census has been clearly and fully demonstrated and they so report."

Of the very few states and cities having any system of registration, Maine, New Hampshire and Vermont use the card catalogue system which consists of a copy of the original return placed upon individual cards by town clerks and forwarded to the state registrar. These cards are then sorted by hand, and the cards filed away as a card catalogue for future reference. As these returns are received monthly, it is possible to keep the compilation well advanced so that at the end of the year a sum total of the months will give total for the year. This system also has the advantage of making it possible to correct any ill defined causes of death, by correspondence with the physician before the end of the year.

New York City makes use of the Hollerith Tabulating Machine, the smaller numbers being counted by hand. The State of Rhode Island made use of the entire Hollerith machine for two or three years, when it was found to be more practicable to sort the punched cards by hand

instead of running them through the electrical counting machine. It is found also that the cards could be punched with greater rapidity, and sorted more readily, than by using the Pidgin card system, which requires markings with pencil.

It is a difficult matter to satisfactorily explain the workings of these various devices without having the machines at hand for demonstration, and should any registrar contemplate the use of any of them, he would naturally visit and examine the devices wherever they might be in operation.